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THE

## EMBRYOLOGY

-- OF-

## CREPIPULA

- BY-

ED WIN GRANT CONKLIN

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54.338

## Preliminary Note on the Embryology of Crepidula fornicata and of Urosalpinx cinerea. By E. G. CONKLIN.

Crepidula fornicata.

The time and manner in which Crepidula lays its eggs has been described by Dr. McMurrich.'

The cleavage follows the type found in Fusus, Planorbis, Neritina, etc. The first furrow is, with regard to the future embryo, a median longitudinal one, and divides the ovum into exactly equal right and left halves. (The method of determining the relation of the first furrow to the embryo cannot be explained without several figures). The second furrow is at right angles to the first and transverse to the long axis of the embryo, and it divides the egg into four equal macromeres. Of these, two meet in the centre in a line which Rabl2 has called the "cross furrow;" the other two are acute toward the centre and do not meet each other. By the position of the macromeres with regard to the "cross furrow," the first and second cleavage furrows may easily be distinguished, e.g., if the egg be viewed from the formative pole and so that one of the cleavage furrows is in the line of vision, the macromere to the right of this furrow and farthest from the observer will be acute at its centre if the furrow in the line of vision be the second cleavage furrow; it will be obtuse, i. e., will meet the opposite macromeres in the "cross furrow" if the furrow in the line of vision be the first cleavage furrow. Of course the reverse would hold true if the egg were viewed from the vegetative pole. The examination of many hundreds of eggs has shown that the position of the macromeres in relation to the "cross furrow" and to the first and second cleavage planes is a constant one, and that the first and second furrows may always be distinguished in the way mentioned. The macromeres as distinguished from the micromeres do not again divide until late in the course of segmentation, and as they do not change their relative position it becomes very easy to orient all the future furrows and cells with reference to the first two furrows. The polar bodies which are at the centre of the ectodermal area also mark the centre of the dorsal surface of the embryo, while the blastopore closes and the definitive mouth appears almost directly opposite them. Until after the formation of the blastopore the chief axis is the one drawn from the centre of the ectodermal to the centre of the endodermal area; with regard to this axis the egg is for some time radially symmetrical; the chief axis of the embryo (the antero-posterior) is at right angles to the chief axis of the egg. At an early period there is a trace of a segmentation cavity, which however is soon obliterated. The formation of micromeres proceeds with wonderful regularity, following the law formulated by Rabl,3 new micromeres always being formed in fours either by being cut off from the four macromeres or by the division of four micromeres already formed. When twenty-four micromeres have been formed one of the macromeres, which later developments show to be on the posterior side of the ovum and to the left of the median line, divides into a larger ventral and a smaller dorsal moiety. The smaller cell, which, unlike the ectoderm cells, contains yolk, moves to the right until it comes to lie at the posterior end of the median furrow between the two posterior macromeres; it very soon divides into a right and a left half, and at a later stage these two cells give rise to two mesoblastic bands which extend forward over the right and left sides of the dorsal surface.

Save for these mesoblasts the radial symmetry at the stage with thirty-six micromeres is perfect. At this stage twelve of the micromeres

<sup>&</sup>lt;sup>1</sup> A contribution to the Embryology of the Marine Prosobranchs. Studies from Biol. Lab., J. H. U., Vol. 3.

<sup>2</sup> Carl Rabl, Ueber die Entwicklung der Tellerschnecke. Morph. Jahrbuch, Bd. 5.
3 Loc, cit.



form a cross with three cells in each arm, the crossing of the arms being exactly at the centre of the ectodermal area. Two of the arms lie in the antero posterior axis, two in the transverse axis; one arm is anterior, one posterior, one right and one left. In the next stage the radial symmetry is no longer perfect, since three arms of the cross lengthen so as to contain four cells each, while the posterior arm does not lengthen until later. However, with this exception, the radial symmetry is preserved until fifty-two micromeres are formed; at this stage the posterior arm lengthens by one cell and the three other arms split longitudinally. At the same time each of the macromeres, except the one mentioned above as giving rise to the mesoblast, divides as did the later into a larger and a smaller moiety. The three smaller cells take positions on the periphery of the egg in the furrows separating the macromeres, one at each end of the transverse furrow and one at the anterior end of the longitudinal furrow.

In normal eggs there is not a trace of an invagination at the ectodermal pole, such as has been described for Neritina and Fulga, though eggs which were developing abnormally often showed such an invagination together with other irregularities, e. g., the spreading apart of the macromeres and the formation of large yolk containing cells at the periphèry of the ectodermal area instead of the small protoplasmic ectoderm cells which are usually formed.

The gastrula is formed by typical epibole. On all sides the ectoderm cells grow around toward the ventral side at an equal rate; thus the blastopore is formed in the middle of the ventral side. The mesoblasts are carried around with the ectoderm to the ventral side, where they lie at the posterior edge of the blastopore. The mesoblastic bands are soon separated from the mesoblasts; the latter continue to predifferate mesoderm, which extends forward in the lips of the blastopore.

The cross above mentioned resembles very much an arrangement of cells figured by Blochmann! for Noritina, the terminal cells in the transverse arms of which are called by him velar cells. In Crepidula it seems that no part of the transverse arms forms the velum. However, the cells of the posterior arm grow very large, the nuclei are vesicular and stain lightly, and the cells become covered by fine cilia, which protrade through a thin cuticula; though at first these ciliated cells lie wholly on the posterior side of the ovum, they move forward in the course of development until they come to lie on the anterior side, and as they increase enormously in size, though they seldom divide, it comes about that they cover the anterior part of the dorsal area, extend around over the anterior end of the embryo and down over its sides. These cells finally form the walls of a large head vesicle.

The velum appears first on the ventral side, just anterior to the mouth, and consists at first of a single row of cells. Later it is composed of several rows, some of which are adoral, and at least a single row runs posterior to the mouth. It is not completed dorsally until much later, though soon after the definitive mouth is formed the velum splits on each side of the embryo, and about half way between the ventral and dorsal surfaces, into an anterior and posterior branch; the later continues up over the dorsal surface just posterior to the large cilitated cells; the anterior branch, which is the chief one, turns forward over the sides of the head vesicle, and quite late in development the two arms of the anterior branch meet and fuse on the mid line just in front of the ventral part of the preoral velum. Thus two large velar lobes are formed, one on each side. The posterior branch of the velum appears to be the post-oral cilitated band, the anterior branch the preoral; from the corners of the mouth to the middle of the sides of the embryo the two are fused, while ventrally they are separated by the mouth and dorsally by the whole diameter of the head vesicle. A postoral band of cilia has been described as present in the veligres of several gastropols, and among these Crepidula; but I am not aware that any one has hitherto

<sup>1</sup> F. Blochmann, Ueber die Entwicklung der Nerttina stuviatilis. Zeit, wiss. Zool., Rd. 26.

<sup>2</sup> McMurrich. J. H. U. Circulars, No. 44, 1885.



The shell gland appears on the dorsal surface immediately poeterior to the second or transverse furrow as a prominence of ectoderm cells. In the place of this prominence an invacination afterward appears; the margin of the invagination extends rapidly and a thin cutilet, the first indication of the shell, is secreted by the invaginated cells. As development proceeds the shell becomes asymmetrical, developing more rapidly on the left side than on the right.

The foot arises as a single median protuberance just posterior to the mouth. While it shows no trace of a double origin, it occupies a region along which the blastopore closed, so that really the foot may be considered as having arisen on both sides of the blastopore, though the lips of the latter have fused before the former appears. Running from the mouth backward over the median surface of the foot is a row of large ciliated cells resembling those on the dorsal area.

At the posterior end of the embryo three or four large ciliated anal cells appear, and just ventral to these the distal end of the intestine is pressed against the ectoderm. The proctodeal invagination does not occur until late in development. The intestine is a tube with a distinct lumen, its walls being formed of small cells free from yolk. In the course of development its central end, where it opens into the eavity between the yolk spheres is carried anteriorly and to the right. Throughout its whole length the intestine is pressed closely against the extuderm.

The supra-oesophageal ganglia appear as proliferation of the ectoderm on each side of and dorsal to the mouth; the eyes are formed in connection with these ganglia as involutions of ectoderm. The ganglia of the two sides are connected by a commissure, and from the centre of the latter a nerve runs forward to the centre of the spical plate, where there is a ciliated depression in the ectoderm, which I believe is a sense organ. A commissure connects the supra-oesophageal ganglion of each side with the otocysts. The latter are formed by involution of the ectoderm of the foot, and the pedal ganglion is formed by delamination from the ectoderm at the sides of the foot, and the pedal ganglion is formed by delamination from the ectoderm at the sides.

## Urosatpinx cinered

The breeding habits of Urosalpinx have been fully described by Professor Brooks.\(^3\) The segmentation is almost identical with that described by Professor Brooks\(^4\) for the oyster, and closely rescables the segmentation of Nassa, as described by Bobretzky\(^3\). The chief difference between the segmentation in Urosalpinx and Crepidula consists in the fact that while the four macromeres of Crepidula are equal in size, the four macromeres of Urosalpinx are very unequal, one being very much larger than the other three. Two furrows appear simultaneously and seem to divide the ovum into one large sphere and two smaller ones. Really, however, one of the smaller spheres is not completely separated from the larger one, and soon after fuses with it. This smaller sphere is merely a constricted portion of the larger sphere and contains the nucleus. Thus it is seen that of the two furrows meltioned, but one is a true cleavage furrow and it divides the egg into a larger and a smaller moiety. At the next stage the smaller moiety divides into two equal parts, and at the same time two protuberances, each containing a nucleus, are pushed out from the larger moiety. One of these

<sup>&</sup>lt;sup>3</sup> Preliminary observations on the development of the Marine Prosobranchs. Studies from the Biological Laboratory, J. H. U., Vol. 1.
<sup>4</sup> The Embryology of the Oyster. Studies from the Biological Laboratory, J. H. U.,

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5 N. Bobretzky. Studien überdie Embryonale Entwicklung der Gasteropoden. Archiv.



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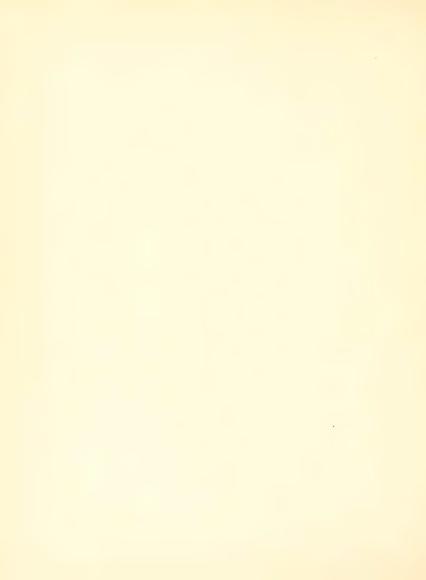
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Fig. 41 . 1 to the first comme a ser or are in the in allocations articipalities of our Ver bet in if some un is to The thestope. mentaline rasing the subject.



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Fig. 52 =

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